Output Power Characterization of a Q-Switched Fiber Laser

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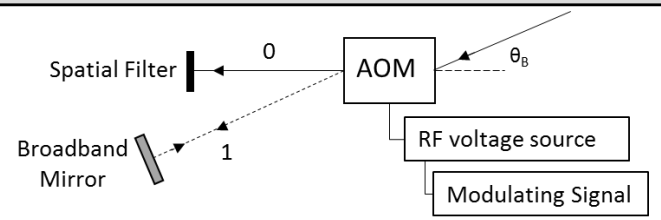
Introduction

A Q-switched fiber laser was built using a 3-meter segment of two-core Ytterbium (Yb) doped optical fiber [1]. Pulsed laser output with a repetition rate of 1kHz was obtained from one core of the fiber, and the optical power contained in a single pulse P_{peak} was determined using measurements of average power P_{avg} and pulse width t_{pulse}.

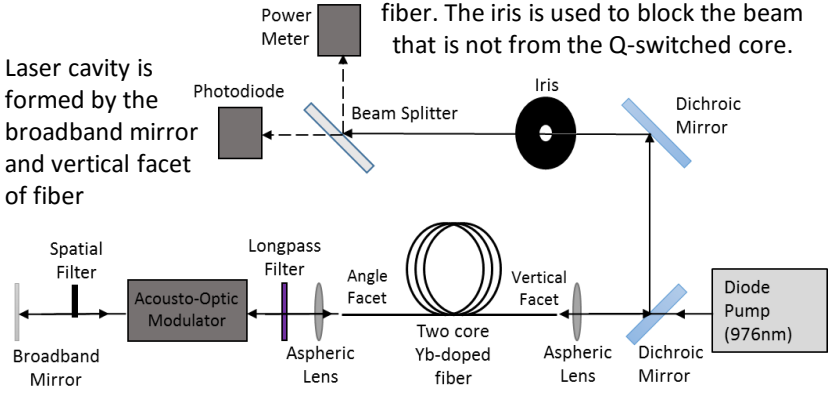
Theory



An Acousto-Optic Modulator (AOM) diffracts an incident light beam into two orders (0 and 1). The optical power in 1 is maximized when the incident beam enters the AOM at the Bragg angle θ_B [2]. Spatial filter blocks 0, and 1 is reflected back through AOM and into a single fiber core using a broadband mirror, completing the laser cavity. Quickly modulating the RF source on and off periodically completes and breaks (Q-switches) the laser cavity, resulting in pulsed output.

Apparatus and Methods

Laser cavity is formed by the broadband mirror and vertical facet of fiber



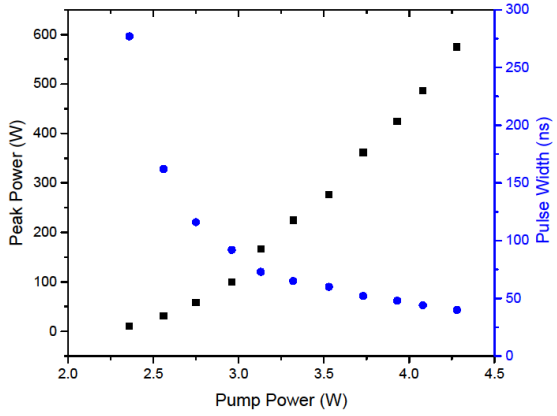
Two beams of light are output from the fiber. The iris is used to block the beam that is not from the Q-switched core.

50/50 beam splitter directs Q-switched output to a power meter to measure $P_{avg}/2$ and to a photodiode to measure t_{pulse}. P_{peak} is found using:

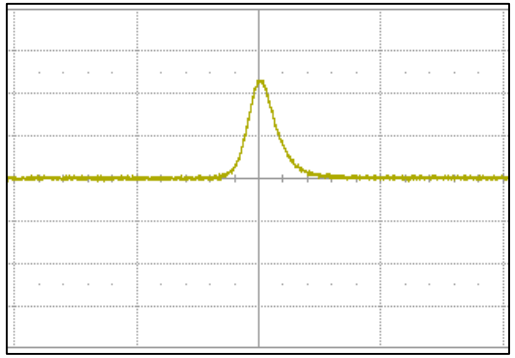
$$P_{peak} = \frac{P_{avg}}{f t_{pulse}}$$

where f = 1kHz, the pulse repetition rate [3].

Results



Oscilloscope Trace of Pulsed Output



(Pump Power = 3.32W)
x-axis: 200ns/division, y-axis: 100mV/division

Conclusion

The fiber can easily withstand peak powers between 500W and 600W, which are obtained using relatively small pump powers. These peak powers are believed to be more than sufficient to observe self-phasing due to the Optical Kerr Effect in a beam combining experiment.

The fiber core that was not Q-switched was found to lase by itself, perhaps due to a poor angle facet or internal fiber damage. The fiber must be replaced if this setup is used in a beam combining experiment.

Acknowledgements

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References

[1] A. Yariv, P. Yeh, *Photonics: Optical Electronics in Modern Communications*, 6th ed. Oxford University Press, New York, 2007.
[2] J. W. Goodman, *Introduction to Fourier Optics,* 3rd ed. Roberts and Company, 2005.
[3] http://assets.newport.com/webDocuments-EN/images/20063.PDF

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